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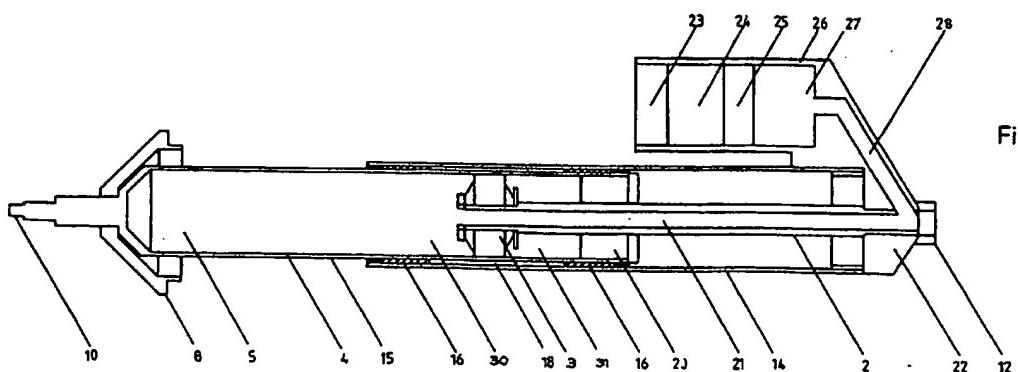
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(54) Abstract Title  
Damper

(57) A damper comprises a cylinder 4, a piston rod 2, a case 14 attached to the piston rod and cooperating with the outer surface 15 of the cylinder to maintain the alignment of the piston rod with the cylinder, and a reservoir 26 in fluid communication with the cylinder and mounted on the case. Fluid communication between the cylinder and the reservoir is via one or more longitudinal bores 21 in the piston rod. Preferably the reservoir is connected to the bore by a rigid conduit 28 in an end plug 22 of the case. This arrangement avoids the need for a flexible hose between the cylinder and the reservoir and facilitates the removal of a shock absorber spring surrounding the damper.

In an alternative arrangement of a double cylinder damper with an annular piston in the outer cylinder, the reservoir is mounted on the piston and in fluid communication with the piston rod.



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Fig. 2

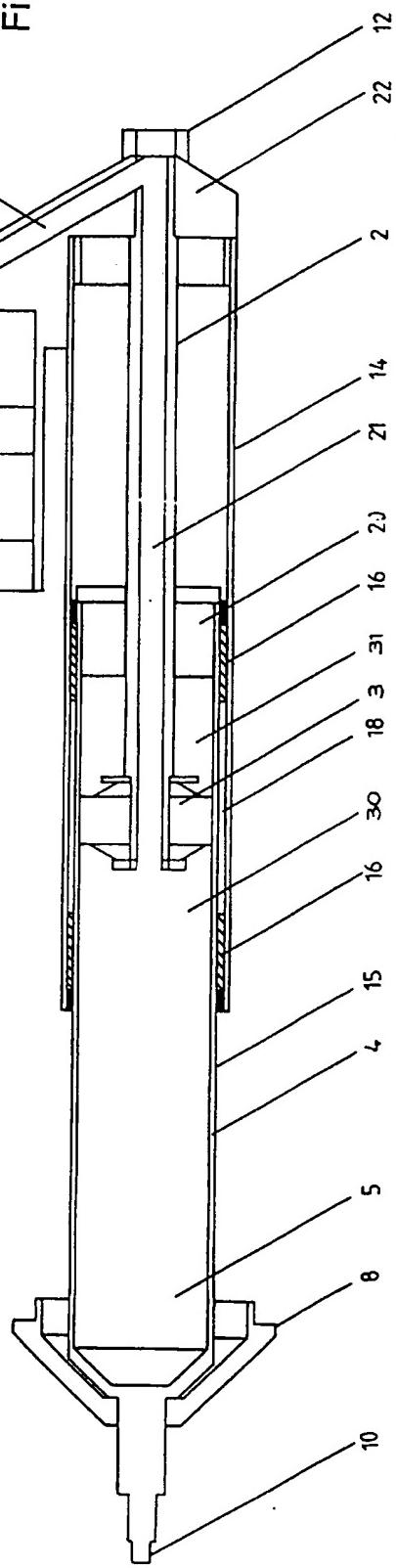
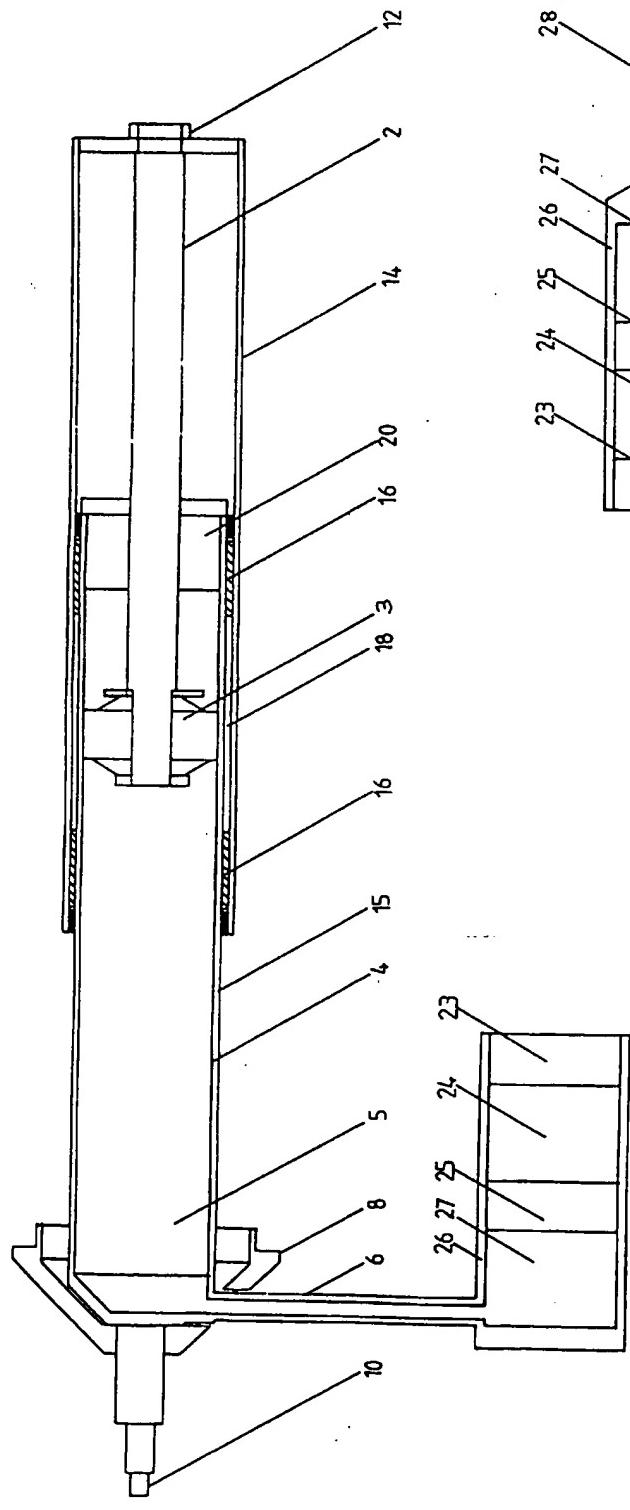


Fig. 1



TITLE

Damper with strut case mounted reservoir

DESCRIPTION

Field of the invention

The invention relates to the field of dampers using a fluid as a damping medium. It has particular application to a damper used as a strut for a motor vehicle.

Background of the invention

Figure 1 illustrates a known damper including a piston rod 2 slidably received in a cylinder 4 containing a fluid damping medium 5. The cylinder 4 is sealed around the piston rod 2 by a cylinder end plug 20. A piston 3 is mounted on the piston rod 2 within the cylinder 4 so that movement of the piston 3 along the cylinder 4 is resisted by the damping fluid 5. Thus forces applied along the piston rod 2 are damped by the dissipation of energy as heat in the damping fluid 5.

The performance of the damper becomes degraded during intensive use as the temperature of the damping fluid 5 increases. Such degradation in performance may be reduced by increasing the volume of damping fluid 5 available for the dissipation of energy. Accordingly, a reservoir 26 of damping fluid is connected to the cylinder 4 via a hose 6. The hose 6 is generally a flexible hose that is coupled to the cylinder 4 at the end remote from the piston rod 2 and the reservoir 26 is mounted on the vehicle body.

The reservoir 26 may also be used to increase the stroke potential of the damper unit or to provide means of compression adjustment by restricting the flow of fluid displaced by the piston rod 2 during compression travel.

The reservoir 26 contains a damping fluid compartment 27 in communication with the hose 6 and a pressurized gas compartment 24 separated from the fluid compartment 27 by

a floating piston 25. The gas compartment 24 is sealed with a reservoir end plug 23. As the piston rod 2 is inserted into the cylinder 4, its volume displaces fluid 5 from the cylinder 4. The displaced volume of damping fluid 5 is accommodated in the fluid compartment 27 of the reservoir 26 by movement of the floating piston 25 to reduce the volume of the gas compartment 24.

The illustrated damper is in the form of a MacPherson strut, which is a load-bearing member associated with the front or rear wheel of a vehicle. The strut may include means 8 for mounting a suspension spring, means 10 for attaching one end of the strut to the body of the vehicle and means (not shown) for attaching the other end of the strut to the vehicle wheel, hub assembly or upright.

To allow the strut to withstand bending loads, a strut case 14 surrounds and supports the cylinder 4. An end plug 12 of the strut case 14 is attached to the outer end of the piston rod 2. As the piston rod 2 slides into and out of the cylinder 4, the strut case 14 slides over an outer surface 15 of the cylinder 4 on two or more bearings 16. Between the bearings 16 is a space 18 which may be filled by a lubricant, typically grease. Generally both bearings 16 are formed on an inner surface of the strut case 14 so that the spacing between them is fixed. As an alternative, one bearing may be formed on the outer surface of the cylinder 4, in which case the spacing between the bearings 16 will vary as the piston moves.

The arrangement in which the vehicle body attachment 10 is on the damper cylinder 4, the vehicle wheel attachment is on the strut case 14 and the working piston 3 acts directly on the bore of the cylinder 4 is known as an inverted monotube MacPherson strut.

An alternative arrangement of damper, illustrated for example in patent application EP-A-0607545, is a

non-inverted monotube. It comprises an inner cylinder in which a piston rod is slidably received and an outer cylinder surrounding the inner cylinder to form an annular chamber. A further, annular piston is coupled to the piston rod and slidably received in the annular chamber.

In the prior art damper described with reference to Figure 1, the hose 6 is particularly vulnerable to damage. This may occur from the impact of stones and other particles thrown up beneath the vehicle as it is driven. Another cause of damage to the hose 6 is rotation of the cylinder 4 relative to the strut case 14. Commonly, the strut may turn as a whole when the vehicle is steered in one direction but when the vehicle is steered back the cylinder 4 may not return fully to its original angular position relative to the strut case 14. Such relative rotation leads to distortion of the hose 6 and eventually to damage.

A further disadvantage of the hose 6 is that it may impede removal of the shock absorber spring (not shown) that surrounds the damper and is mounted on the mounting means 8. Particularly in the context of motor sport it is desirable for the spring to be changeable easily and quickly but the need to disconnect and reconnect the hose 6 or alternatively to separate the cylinder 4 from the strut case 14 adds to the complexity and duration of the process.

A flexible hose has the further disadvantage that when the damper is subjected to high compression impulses, the hose may expand and adversely affect the characteristics of the damper.

#### Summary of the invention

The invention provides a damper comprising:

a cylinder;

a piston rod slidably received in the cylinder;

a case attached to the piston rod and cooperating with the outer surface of the cylinder to maintain the alignment of the piston rod with the cylinder; and  
a reservoir in fluid communication with the cylinder;

CHARACTERIZED IN THAT:

the reservoir is mounted on the case; and  
the fluid communication between the cylinder and the reservoir is via a longitudinal bore in the piston rod.

This invention overcomes the disadvantages of the prior art because the fluid communication through the piston rod avoids the need for a hose connection to the external walls of the cylinder. A shock absorber spring surrounding the damper can accordingly be replaced comparatively easily with no need to disconnect and reconnect a hose. Furthermore, the mounting of the reservoir on the strut case prevents any relative movement between the reservoir and case so the fluid connection to the reservoir does not suffer the distortion that led to damage in the hose of the prior art.

Preferably the case includes an end plug attached to the piston rod and the reservoir is connected to the longitudinal bore in the piston rod by a rigid conduit in the end plug of the case. The rigid conduit is better able to withstand impacts than the flexible hose of the prior art. It does not expand during compression impulse pressures, thus allowing a more precise level of compression adjustment in the reservoir.

The invention may be adapted for application to a monotube or a twin tube damper, inverted or non-inverted. It can also be applied to the aforementioned arrangement in which an outer cylinder defines an annular chamber containing an annular piston coupled to the piston rod. In this case the reservoir is mounted on the annular piston and the

fluid communication between the cylinder and the reservoir is again via a longitudinal bore in the piston rod.

Brief description of the drawings

Figure 1 illustrates schematically and partially in section a damper according to the prior art.

Figure 2 illustrates schematically and partially in section a damper according to the invention.

Description of a preferred embodiment

In Figure 2 is shown a damper according to the present invention. Corresponding parts have been given the same reference numerals as in Figure 1 and the explanation of those parts will not be repeated.

The damper according to the invention differs from the prior art damper of Figure 1 in that the reservoir 26 is mounted on the strut case 14. The fluid connection between the cylinder 4 and the fluid compartment 27 of the reservoir 26 is through a bore 21 extending along the length of the piston rod 2. The end plug 22 of the strut case 14 is formed as an integral unit with the reservoir 26, and a conduit 28 through the end plug 22 connects the bore 21 in the piston rod 2 to the fluid compartment 27 of the reservoir 26.

The operation of the damper illustrated in Figure 2 is similar to that of the prior art damper in Figure 1. As the piston rod 2 is inserted into the cylinder 4, the displaced volume of damping fluid 5 flows along the bore 21 and the conduit 28 into the fluid compartment 27 of the reservoir 26, where it is accommodated by movement of the floating piston 25 to reduce the volume of the gas compartment 24.

The invention overcomes the disadvantages of the prior art because the mounting of the reservoir 26 on the strut case

14 prevents any relative movement between them. The fluid connection to the reservoir 26 can accordingly be through a rigid conduit 28 that is better able to withstand impacts than the flexible hose 6 of the prior art and does not expand under compressive impulses. Furthermore, there can be no relative rotation between the strut case 14 and the reservoir 26 mounted on it so the conduit 28 does not suffer the distortion that led to damage in the hose 6 of the prior art.

Because there is no hose connection to the external walls of the cylinder 4, a shock absorber spring (not shown) surrounding the damper can be replaced comparatively easily by removal of the spring mounting means 8, with no need to disconnect and reconnect a hose.

It should be remembered that Figures 1 and 2 are schematic and are not intended to represent the true shapes of the reservoirs 26 or their configurations relative to the dampers. In practice, the reservoir 26 in the damper according to the invention may be designed in a variety of shapes and may be mounted on the strut case 14 in any convenient manner. The chosen configuration may provide additional protection from damage for the conduit 28.

In the illustrated embodiment the bore 21 extends through the full length of the piston rod and to emerge in the fluid chamber 30 remote from the cylinder end plug 20. Alternatively, instead of extending fully through the piston, the bore 21 could be made to emerge laterally from the piston rod 2 into the fluid chamber 31 adjacent to the cylinder end plug 20.

In a further alternative embodiment (not illustrated), a plurality of bores 21 may be provided through the piston rod 2, each connected to a respective reservoir 26 formed integrally with the end plug 22. In particular, if there are two such bores 21, the two associated reservoirs 26

may be connected to each other through a further conduit containing a one-way valve. This arrangement promotes circulation of the fluid 5 between the reservoirs 26 and the cylinder 4 so that the temperature is more uniform throughout the fluid 5, heat dissipation is more effective and damping is more efficient.

CLAIMS

1. A damper comprising:  
a cylinder (4);  
a piston rod (2) slidably received in the cylinder (4);  
a case (14) attached to the piston rod (2) and cooperating with the outer surface (15) of the cylinder to maintain the alignment of the piston rod (2) with the cylinder (4); and  
a reservoir (26) in fluid communication with the cylinder (4);  
CHARACTERIZED IN THAT:  
the reservoir (26) is mounted on the case (14); and  
the fluid communication between the cylinder (4) and the reservoir (26) is via a longitudinal bore (21) in the piston rod (2).
2. A damper according to claim 1, wherein:  
the case (14) includes an end plug (22) attached to the piston rod (2); and  
the reservoir (26) is connected to the longitudinal bore (21) in the piston rod (2) by a rigid conduit (28) in the end plug (22) of the case (14).
3. A damper according to claim 1 or claim 2, wherein the reservoir (26) is formed integrally with the end plug (22).
4. A damper according to any preceding claim, further including a second reservoir mounted on the case (14); and  
a second longitudinal bore in the piston rod (2) providing fluid communication between the cylinder (4) and the second reservoir (26).
5. A damper according to claim 4, further including a one-way fluid connection between the first reservoir (26) and the second reservoir.

6. A damper according to any preceding claim, wherein the damper is an inverted monotube.

7. A damper according to any preceding claim, wherein the damper is a strut.

8. A damper according to claim 7, wherein the damper is a MacPherson strut.

9. A damper comprising:

an inner cylinder;

a piston rod slidably received in the inner cylinder;

an outer cylinder surrounding the inner cylinder to form an annular chamber therebetween;

an annular piston slidably received in the annular chamber, the annular piston being coupled to the piston rod; and

a reservoir in fluid communication with the cylinder;

CHARACTERIZED IN THAT:

the reservoir is mounted on the annular piston; and

the fluid communication between the cylinder and the reservoir is via a longitudinal bore in the piston rod.

10. A damper substantially as described herein with reference to Figure 2 of the drawings.



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Application No: GB 9701872.5  
Claims searched: 1 - 8

Examiner: Howard Reeve  
Date of search: 27 March 1997

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2S (SBL)

Int Cl (Ed.6): F16F 9/00, 9/32

Other:

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
	NONE	

- |   |   |   |  |
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